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Hsu et al.

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(54) **HIGH-DENSITY CABLE END CONNECTOR**

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H01R 13/6582	(2011.01)
H01R 13/6586	(2011.01)
H01R 13/66	(2006.01)
H01R 13/6461	(2011.01)

(52) **U.S. Cl.**

CPC ***H01R 24/30*** (2013.01); ***H01R 13/6582*** (2013.01); ***H01R 13/6586*** (2013.01); ***H01R 13/6594*** (2013.01); ***H01R 13/6658*** (2013.01); *H01R 13/6461* (2013.01)

(58) **Field of Classification Search**

USPC 439/607.31

See application file for complete search history.

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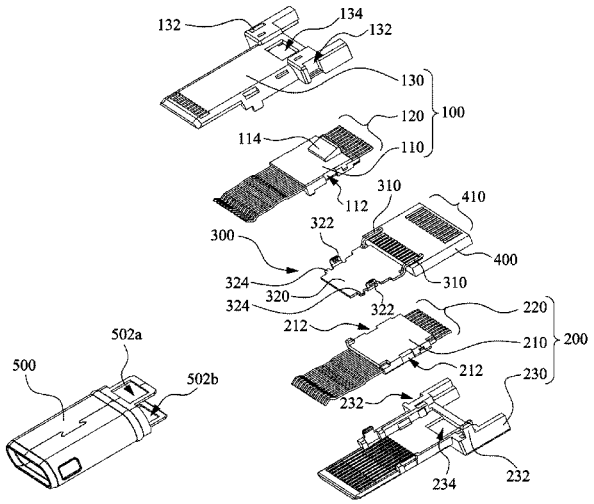
(57) **ABSTRACT**

A high-density cable end connector for transmitting high-frequency signals includes a first sub-assembly, a second sub-assembly, a printed circuit board, a shielding plate, and a shielding shell. The first sub-assembly includes first contacts, a first insulator, and a first cover body. The second sub-assembly includes second contacts, a second insulator, and a second cover body. The printed circuit board includes pins connected to the first contacts and the second contacts. The shielding shell at least partially surrounds peripheries of the first sub-assembly and the second sub-assembly. The shielding plate is disposed between the first contacts and the second contacts and fixed to the first insulator or the second insulator for insulating the first contacts from the second contacts. Therefore, the high-density cable end connector is prevented from having crosstalk resulted by high frequency signals between the first contacts and the second contacts.

9 Claims, 6 Drawing Sheets



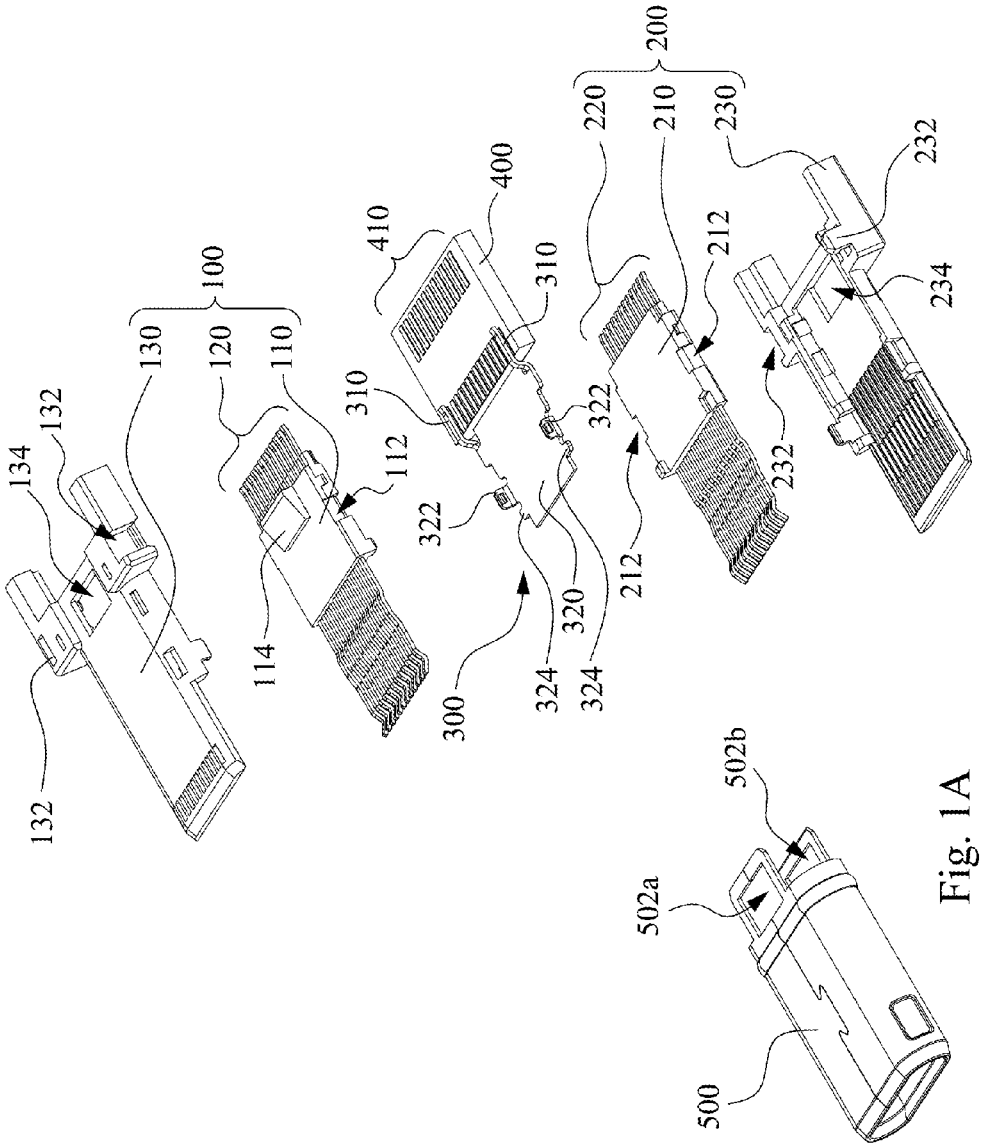

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Fig. 1A

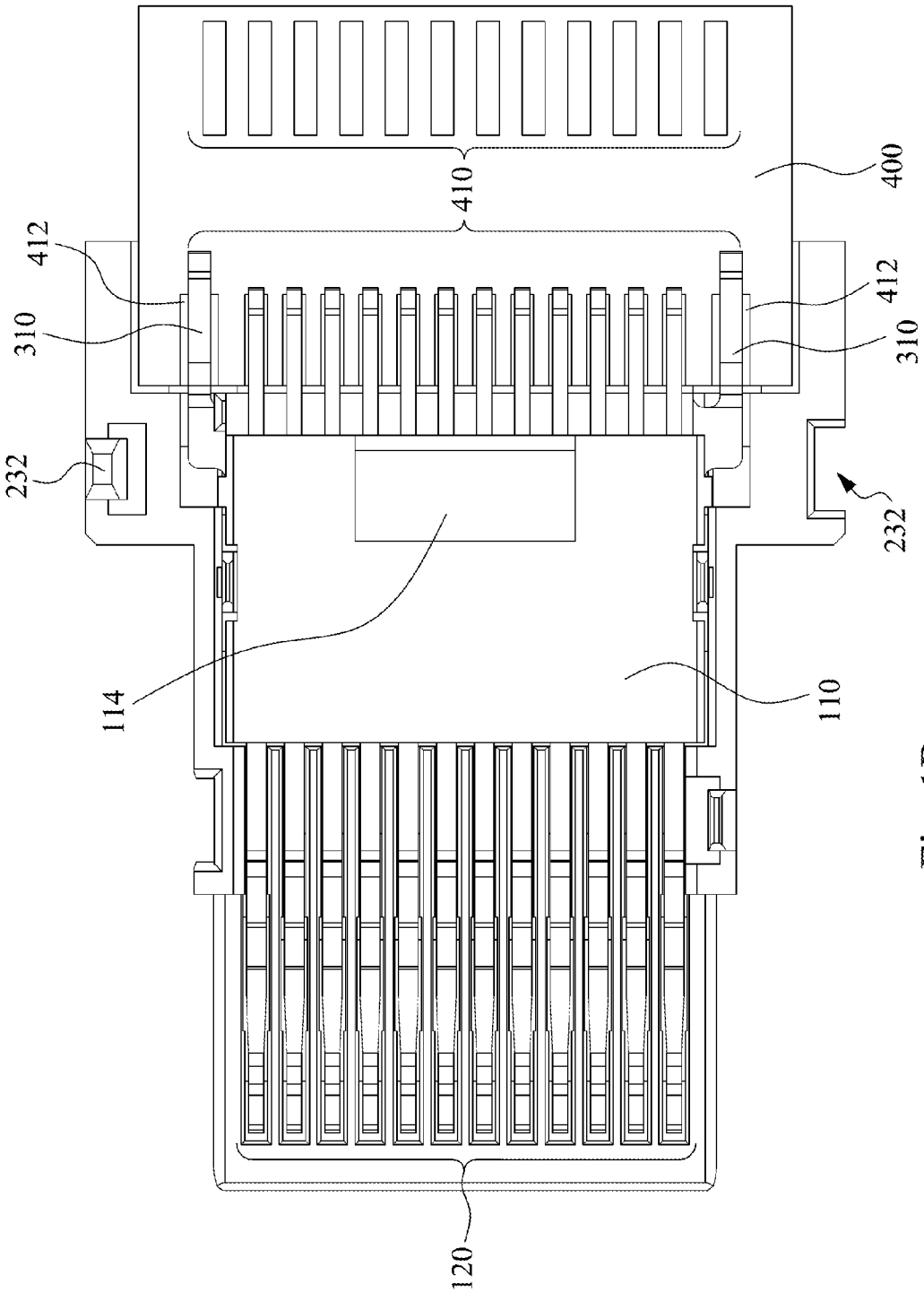

Fig. 1B

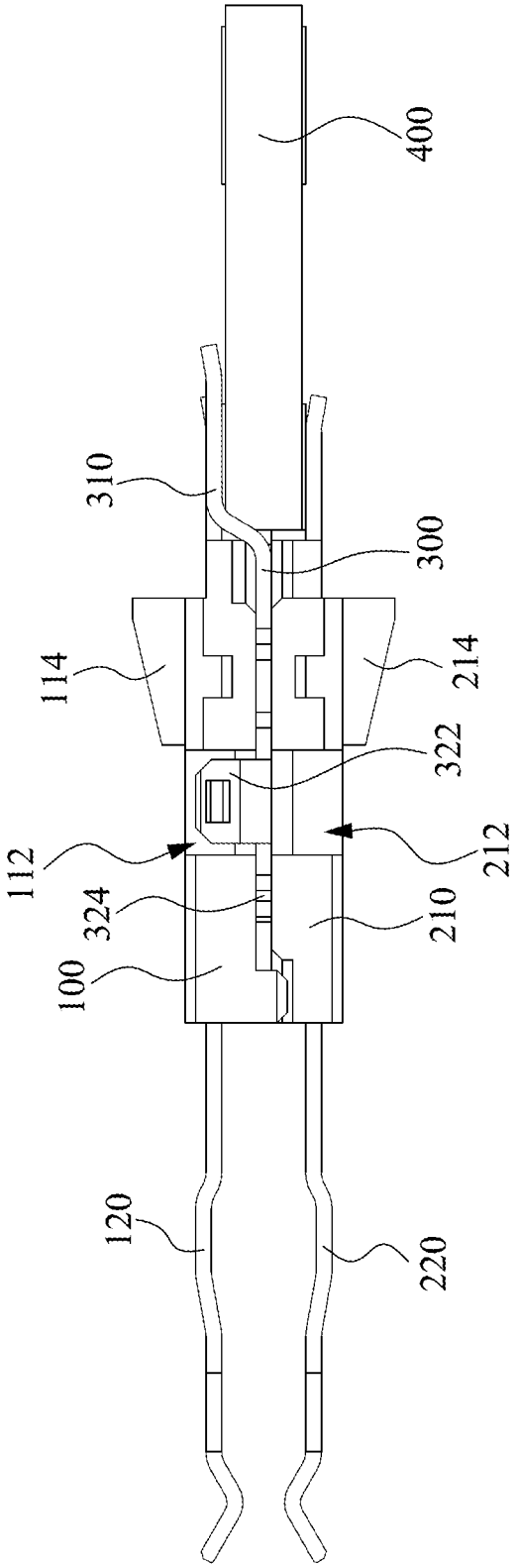

Fig. 1C

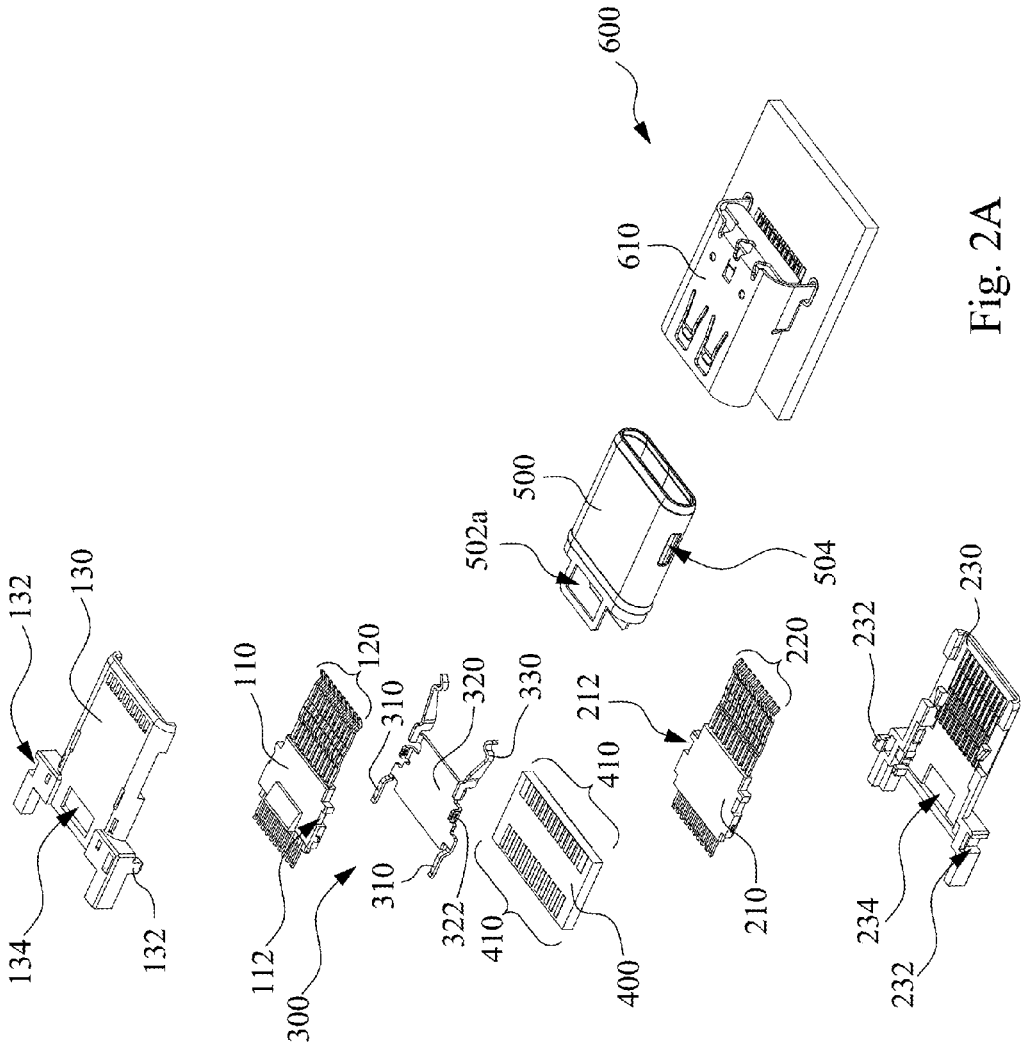
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Fig. 2A

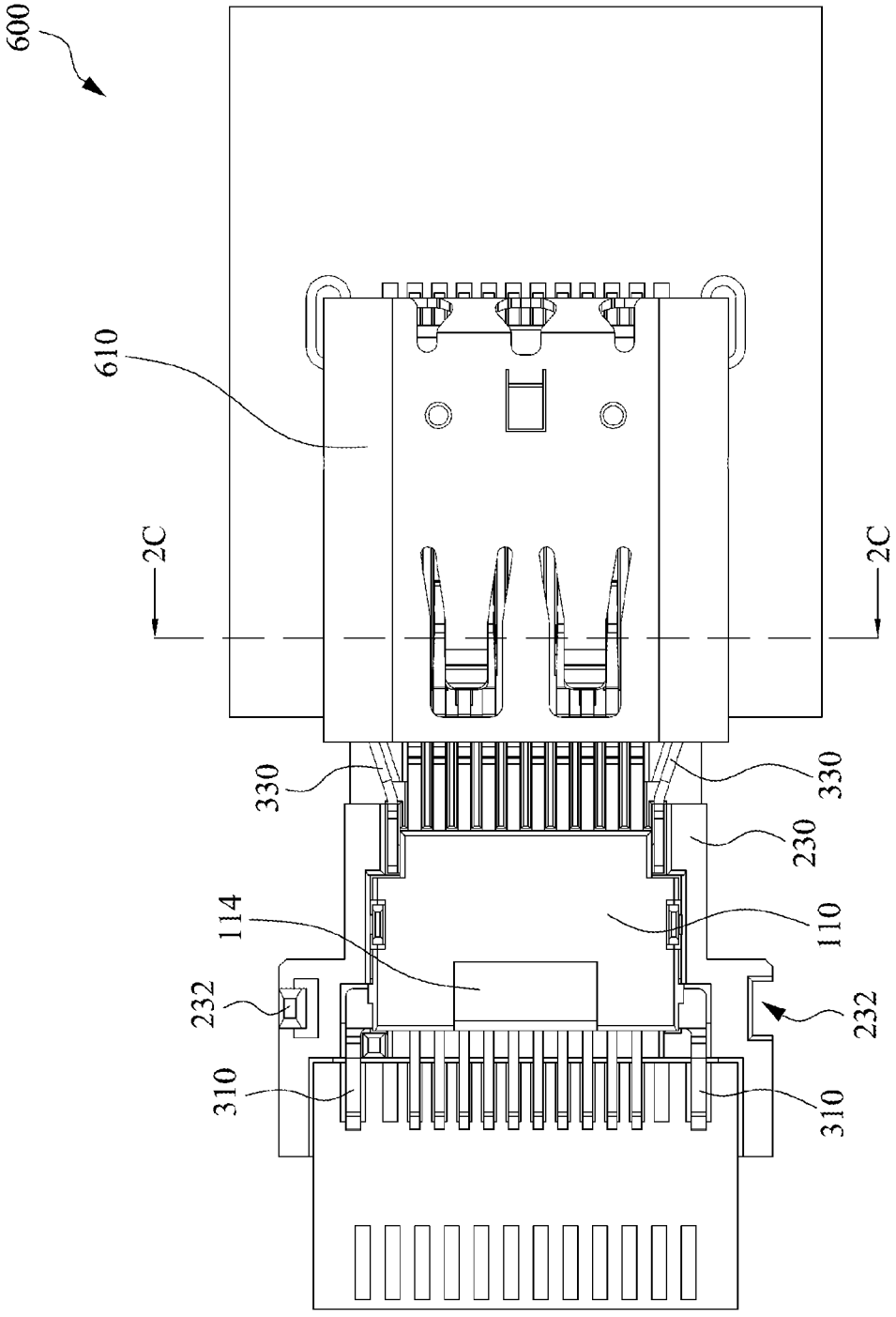

Fig. 2B

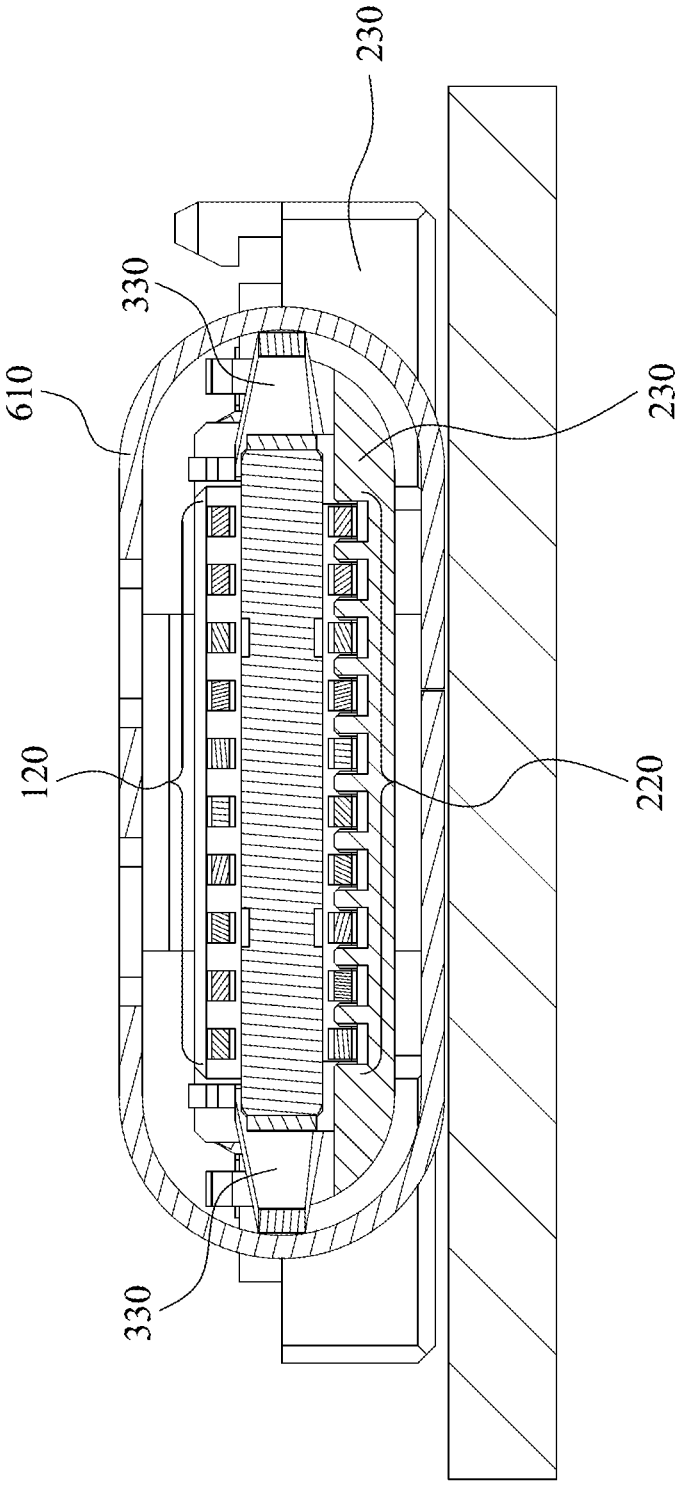

Fig. 2C

HIGH-DENSITY CABLE END CONNECTOR

RELATED APPLICATIONS

This application claims priority to Taiwanese Application Serial Number 103202720, filed Feb. 17, 2014, which is herein incorporated by reference.

BACKGROUND

1. Field of Invention

The present invention relates to a high-density cable end connector. More particularly, the invention relates to a connector for transmitting high frequency electronic signals with a frequency level up to more than Megahertz (MHz), and a cross-sectional unit area of the connector has plural contacts.

2. Description of Related Art

In recent years, the information technology has grown tremendously, and the amount of data transmitted between plural electronic devices is increased continuously. How to transmit a large amount of data in a shorter time is a main trend of development in the information technology. In addition to increasing the number of signal paths for transmitting electronic signals between the electronic devices, a general solution is to increase the frequency of the electronic signals transmitted between the electronic devices. A connector is a bridge for transmitting electronic signals between different electronic devices. As the requirement of the amount of transmitting data is increasing, the connector faces the challenge of the transmission of the high frequency electronic signals.

Due to the trend of miniaturization of electronic devices, the entire size of the connector has to be reduced continuously, and thus the distance between two conductive contacts arranged on the connector is also reduced continuously (i.e., the density of contacts per unit of cross-sectional area is increased). However, the continuously reduced distance between two conductive contacts is disadvantageous to the transmission of high frequency electronic signals, because the high frequency electronic signals transmitted by the respective conductive contacts easily cause crosstalk due to the small gaps of the conductive contacts, thus causing the original transmitted high frequency electronic signals to generate noise. Therefore, in the configuration of the connectors, the reasons disadvantageous to the transmission of high frequency electronic signals have to be taken into consideration, and should be controlled or resolved by appropriate measures so as to lower their substantial effects.

SUMMARY

Embodiments of the present invention provide a high-density cable end connector for transmitting high-frequency signals, and the connector is at least suitable for transmitting high frequency electronic signals with a frequency level up to more than Megahertz (MHz). The high-density connector refers to a connector having a greater amount of conductive contacts per unit of cross-sectional area, that is, the connector of which respective conductive contacts have smaller gaps.

According to one embodiment of the present invention, a high-density cable end connector includes a first sub-assembly, a second sub-assembly, a printed circuit board, a shielding plate, and a shielding shell. The first sub-assembly includes a first insulator, plural first contacts fixed in the first insulator, and a first cover body covering the first contacts and the first insulator. The second sub-assembly includes a second insulator, plural second contacts fixed in the second insulator, and a second cover body covering the second contacts and the second insulator. The shielding plate is disposed between the first contacts and the second contacts and fixed to the first insulator or the second insulator. The printed circuit board includes multiple pins, and the first contacts and the second contacts are connected to the pins on two opposite sides of the printed circuit board. The shielding shell at least partially surrounds peripheries of the first sub-assembly and the second sub-assembly.

In one or more embodiments, the shielding plate includes at least one extension portion extending outwards to be in contact with a ground end of the printed circuit board.

In one or more embodiments, the shielding plate includes a plate body and at least two fastening elements extending from the plate body, and the fastening elements are disposed at two opposite side edges of the plate body, and the first insulator includes two sub-fastening elements which are disposed at opposite edges of the first insulator and complementary in shape to the fastening elements, for fixing the shielding plate to the first insulator.

In one or more embodiments, the shielding plate includes a plate body and at least two fastening elements extending from the plate body, and the fastening elements are disposed at two opposite side edges of the plate body, and the second insulator includes two sub-fastening elements which are disposed at opposite edges of the second insulator and complementary in shape to the fastening elements, for fixing the shielding plate to the second insulator.

In one or more embodiments, the shielding plate includes at least one resilient arm connected to a shielding shell of an edge connector.

In one or more embodiments, the first cover body and the second cover body include two engaging elements respectively, and the engaging elements are proximate to the printed circuit board and complementary in shape to each other for fixing the first cover body to the second cover body.

In one or more embodiments, the first insulator and the second insulator include a positioning block respectively, the shielding shell has an opening corresponding to the positioning block, and the opening is engaged with the positioning block.

In one or more embodiments, the first contacts are embedded in the first insulator, and the second contacts are embedded in the second insulator.

In one or more embodiments, the shielding plate is embedded in the first insulator.

In one or more embodiments, the shielding plate is embedded in the second insulator.

In one or more embodiments, by disposing the shielding plate between the first contacts and the second contacts of the high-density cable end connector, and by grounding and removing the charges on the shielding plate through plural paths, the noise generated from the crosstalk caused by the high frequency electronic signals transmitted through the first contacts and the second contacts can be lowered, and therefore the high-density cable end connector is applicable to transmitting high frequency signals.

It is to be understood that both the foregoing general description and the following detailed description are by examples, and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention can be more fully understood by reading the following detailed description of the embodiment, with reference made to the accompanying drawings as follows:

FIG. 1A is a schematic exploded view of a high-density cable end connector according to an embodiment of the present invention;

FIG. 1B is a schematic top view of the high-density cable end connector of FIG. 1A;

FIG. 1C is a schematic side view of the high-density cable end connector of FIG. 1A;

FIG. 2A is a schematic exploded view of a high-density cable end connector according to another embodiment of the present invention;

FIG. 2B is a schematic top view of the high-density cable end connector of FIG. 2A; and

FIG. 2C is a schematic cross-sectional view of the high-density cable end connector viewed along a line 2C-2C of FIG. 2B.

DETAILED DESCRIPTION

Reference will now be made in detail to the present embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

According to one embodiment of the present invention, a high-density cable end connector for transmitting high-frequency signals is provided. FIG. 1A is a schematic exploded view of a high-density cable end connector according to an embodiment of the present invention. The high-density cable end connector includes a first sub-assembly **100**, a second sub-assembly **200**, a shielding plate **300**, a printed circuit board **400**, and a shielding shell **500**. The first sub-assembly **100** includes a first insulator **110** and plural first contacts **120** fixed in the first insulator **110**. The second sub-assembly **200** includes a second insulator **210** and plural second contacts **220** fixed in the second insulator **210**. The shielding plate **300** is disposed between the first contacts **120** and the second contacts **220**, and is fixed to the first insulator **110** or the second insulator **210**. The printed circuit board **400** includes multiple pins **410**, in which the first contacts **120** and the second contacts **220** are connected to the pins **410** on two opposite sides of the printed circuit board **400** respectively. In addition, the shielding shell **500** at least partially surrounds peripheries of the first sub-assembly **100** and the second sub-assembly **200**.

The first sub-assembly **100** and the second sub-assembly **200** of the high-density cable end connector include a first cover body **130** and a second cover body **230** respectively. The first cover body **130** covers the first contacts **120** and the first insulator **110**, and the second cover body **230** covers the second contacts **220** and the second insulator **210**.

In one or more embodiments of the present invention, in the first sub-assembly **100**, the first contacts **120** are embedded in the first insulator **110**. In the second sub-assembly **200**, the second contacts **220** are embedded in the second insulator **210**. The first contacts **120** and the second contacts **220** can be integrally formed with the first insulator **110** and the second insulator **210** respectively through insert molding.

Regarding the assembly and the structure of the high-density cable end connector, the first cover body **130** and the second cover body **230** include an engaging element **132** and an engaging element **232** respectively, and the engaging elements **132** and **232** are proximate to the printed circuit board **400** and complementary in shape to each other. The engaging element **132** of the first cover body **130** can be engaged with the engaging element **232** of the second cover body **230**. In this manner, the first cover body **130** and the second cover body **230** are fixed to each other. For example, one of the engaging elements **132** and **232** has a recess, and the other one of the engaging elements **132** and **232** has a protrusion. By coupling the recess with the protrusion, the engaging elements **132** and **232** can be engaged with each other, and thus the first cover body **130** and the second cover body **230** can be fixed to each other. In this embodiment, the two engaging elements **132** of the first cover body **130** are a recess and a protrusion respectively. The two engaging elements **232** of the second cover body **230** corresponding to the first cover body **130** are a protrusion and a recess respectively. Thus, the structural strength of the connection between the first cover body **130** and the second cover body **230** can be further enhanced.

Reference is made to FIG. 1A and FIG. 1B. FIG. 1B is a schematic top view of the high-density cable end connector of FIG. 1A, in which the top view is viewed from the first sub-assembly **100** to the second sub-assembly **200**. For clear illustration, the first cover body **130** and the shielding shell **500** are not depicted in FIG. 1B. Since the first insulator **110**, the second insulator **210**, and the shielding plate **300** are overlapped, the first insulator **110** can be observed in FIG. 1B, but the second insulator **210** and the shielding plate **300** are not shown. The shielding plate **300** includes at least one extension portion **310**, and the extension portion **310** extends outwards from a plate body **320** of the shielding plate **300** and is in contact with a ground end **412** of the printed circuit board **400**. As a result, the charges on the shielding plate **300** can be grounded through this path. The shielding plate **300** is formed by cutting a thin metal sheet, and thus shielding plate **300** can be used for shielding the electromagnetic waves to prevent the high frequency signals transmitted through the first contacts **120** and the second contacts **220** from being mutually interfered.

Reference is made to FIG. 1A and FIG. **10**. FIG. **10** is a schematic side view of the high-density cable end connector of FIG. 1A. For clear illustration, the first cover body **130**, the second cover body **230**, and the shielding shell **500** are not depicted in FIG. 1C. In one or more embodiments of the present invention, the shielding plate **300** includes the plate body **320** and at least two fastening elements **322** extending from the plate body **320**. The fastening elements **322** are used for fixing the shielding plate **300** between the first contacts **120** and the second contacts **220**. The fastening elements **322** are disposed at two opposite side edges of the plate body **320**. The first insulator **110** includes at least two sub-fastening elements **112** which are disposed at opposite edges of the first insulator **110** and complementary in shape to the fastening elements **322**. The fastening elements **322** of the shielding plate **300** can be engaged with the sub-fastening elements **112** of the first insulator **110**, and thereby the shielding plate **300** is fixed to the first insulator **110**.

On the other hand, in one or more embodiments of the present invention, the shielding plate **300** includes the plate body **320** and at least two fastening elements **322** extending from the plate body **320**. The fastening elements **322** are used for fixing the shielding plate **300** between the first contacts **120** and the second contacts **220**. The fastening elements **322** are disposed at two opposite side edges of the plate body **320**. The second insulator **210** includes at least two sub-fastening elements **212** which are disposed at opposite edges of the second insulator **210** and complementary in shape to the fastening elements **322**. The fastening elements **322** of the shielding plate **300** can be engaged with the sub-fastening elements **212** of the second insulator **210**, and thereby the shielding plate **300** is fixed to the second insulator **210**.

Furthermore, the shielding plate **300** includes at least two lateral wings **324** extending from the plate body **320**. The

lateral wings **324** are disposed at two opposite side edges of the plate body **320**. The lateral wings **324** are used to engage with the metal shell of the edge connector (not shown in the figure), and thus the charges on the shielding plate **300** can be grounded and removed through plural paths.

Regarding the assembly and the structure of the high-density cable end connector, the first insulator **110** may include a positioning block **114**, and an opening **134** of the first cover body **130** and an opening **502***a* of the shielding shell **500** are disposed corresponding to the positioning block **114** in position. The positioning block **114** may pass through the opening **134** of the first cover body **130** and the opening **502***a* of the shielding shell **500**, thereby fastening the first insulator **110**, the first cover body **130**, and the shielding shell **500** to each other. As a result, the first sub-assembly **110** can be fixed to the shielding shell **500**. Similarly, the second insulator **210** may include a positioning block **214**, and an opening **234** of the second cover body **230** and an opening **502***b* of the shielding shell **500** are disposed corresponding to the positioning block **214** in position. The positioning block **214** may pass through the opening **234** of the second cover body **230** and the opening **502***b* of the shielding shell **500**, thereby fastening the second insulator **210**, the second cover body **230**, and the shielding shell **500** to each other. As a result, the second sub-assembly **210** can be fixed to the shielding shell **500**. By using the aforementioned structural configuration constructed by the positioning block **114** of the first insulator **110**, the positioning block **214** of the second insulator **210**, the opening **134** of the first cover body **130**, the opening **234** of the second cover body **230**, the openings **502***a* and **502***b* of the shielding shell **500**, and the engaging elements **132** and **232** between the first cover body **130** and the second cover body **230**, the first sub-assembly **100**, the second sub-assembly **200**, and the shielding shell **500** can be fastened together.

In one or more embodiments of the present invention, in addition to assembling the aforementioned structural elements for fastening the shielding plate **300** to the first insulator **110** or the second insulator **210**, the shielding plate **300** can be directly embedded in the first insulator **110** by insert molding. In another embodiment of the present invention, the shielding plate **300** can be directly embedded in the second insulator **210** by insert molding. As a result, the size of the integrated connector can be reduced, and the shielding plate **300** can be used to enhance the strength of the integrated connector. Furthermore, the first contacts **120**, the second contacts **220**, the first insulator **110**, the second insulator **210**, and the shielding plate **300** can be integrally formed by insert molding.

FIG. **2**A is a schematic exploded view of a high-density cable end connector according to another embodiment of the present invention. The high-density cable end connector of FIG. **2**A is derived from the high-density cable end connector of FIG. **1**A, and thus has a similar basic structural configuration with the high-density cable end connector of FIG. **1**A. In addition to the structural configuration described above, the difference between this embodiment and the embodiment of FIG. **1** resides in the configuration of the lateral wings **324** of the shielding plate **300**. In this embodiment, the lateral wings **324** in the embodiment of FIG. **1** are changed to be at least one resilient arm **330** extending outwards from the shielding body **320** to enter the edge connector **600**. In this embodiment, the resilient arm **330** has a bended shape, but the present invention is not limited thereto.

FIG. **2**B is a schematic top view of the high-density cable end connector of FIG. **2**A. For clear illustration, the first cover body **130** and the shielding shell **500** are not depicted in FIG. **2**B. When the high-density cable end connector is connected to the edge connector **600**, the resilient arm **330** can be extended to enter the edge connector **600** to remove and ground the charges on the shielding plate **300** through plural paths. FIG. **2**C is a schematic cross-sectional view of the high-density cable end connector viewed along a line **2**C-**2**C of FIG. **2**B. The resilient arms **330** are disposed at two sides of the first contacts **120** and the second contacts **220**, and are in contact with the shielding shell **610** of the edge connector **600**. Since the shielding shell **610** is made of metal material, the resilient arms **330** can be electrically connected to the shielding shell **610**. As a result, the charges on the shielding plate **300** can be removed through the shielding shell **610** of the edge connector **600**.

Referring to FIG. **2**A, in one or more embodiments of the present invention, the shielding shell **500** of the high-density cable end connector may have a mating opening **504**, in which the opening **504** is disposed at the two sides of the shielding shell **500** for exposing the resilient arm **330** of the shielding plate **300**.

The shielding plate **300** is positioned between the first contact **120** and the second contacts **220** in the connector, and thus the disposition of the shielding plate **300** has a great influence on the entire transmission of high frequency electronic signals performed by the high-density cable end connector. For example, factors such as the distance between the shielding plate **300** and the first contact **120**, the distance between the shielding plate **300** and the second contacts **220**, and the shape of the shielding plate **300** have serious impacts on the impedances of the first contacts **120** and the second contacts **220** during the transmission of high frequency electronic signals. It is known that the variation of the impedance of the first contacts **120** and the second contacts **220** may result in energy consumption or return loss during the transmission of high frequency electronic signals. Therefore, one skilled in the art can obtain an appropriate impedance compensation through fine tuning the sizes of different parts of the shielding plate **300**, the distance between the shielding plate **300** and the first contact **120**, or the distance between the shielding plate **300** and the second contacts **220**.

In the embodiments of the present invention, by disposing the shielding plate between the first contacts and the second contacts of the high-density cable end connector, and by grounding and removing the charges on the shielding plate through plural paths, the noise generated from the crosstalk caused by the high frequency electronic signals transmitted through the first contacts and the second contacts can be lowered, and thus the high-density cable end connector is applicable to transmitting high frequency signals.

Although the present invention has been described in considerable detail with reference to certain embodiments thereof, other embodiments are possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the embodiments contained herein.

It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention cover modifications and variations of this invention provided they fall within the scope of the following claims.

What is claimed is:

1. A high-density cable end connector for transmitting high-frequency signals, the high-density cable end connector comprising:

a first sub-assembly comprising a plurality of first contacts, a first insulator, and a first cover body, wherein the first

contacts are fixed in the first insulator, and the first cover body covers the first contacts and the first insulator;

a second sub-assembly comprising a plurality of second contacts, a second insulator, and a second cover body, wherein the second contacts are fixed in the second insulator, the second cover body covers the second contacts and the second insulator, and the first cover body is engaged with the second cover body;

a shielding plate disposed between the first contacts and the second contacts, wherein the shielding plate is fixed to the first insulator or the second insulator;

a printed circuit board comprising a plurality of pins, wherein the first contacts and the second contacts are connected to the pins on two opposite sides of the printed circuit board respectively; and

a shielding shell at least partially surrounding peripheries of the first sub-assembly and the second sub-assembly.

2. The high-density cable end connector of claim **1**, wherein the shielding plate comprises a plate body and at least one extension portion extending from the plate body, and the extension portion is in contact with a ground end of the printed circuit board.

3. The high-density cable end connector of claim **1**, wherein the shielding plate comprises a plate body and at least two fastening elements extending from the plate body, and the fastening elements are disposed at two opposite side edges of the plate body, and the first insulator comprises at least two sub-fastening elements which are disposed at opposite edges of the first insulator and complementary in shape to the fastening elements, for fixing the shielding plate to the first insulator.

4. The high-density cable end connector of claim **1**, wherein the shielding plate comprises a plate body and at least two fastening elements extending from the plate body, and the fastening elements are disposed at two opposite side edges of the plate body, and the second insulator comprises at least two sub-fastening elements which are disposed at opposite edges of the second insulator and complementary in shape to the fastening elements, for fixing the shielding plate to the second insulator.

5. The high-density cable end connector of claim **1**, wherein the shielding plate comprises at least one resilient arm electrically connected to a shielding shell of an edge connector.

6. The high-density cable end connector of claim **1**, wherein each of the first insulator and the second insulator comprise a positioning block, and the shielding shell has an opening corresponding to the positioning block, and the opening is engaged with the positioning block.

7. The high-density cable end connector of claim **1**, wherein the first contacts are embedded in the first insulator, and the second contacts are embedded in the second insulator.

8. The high-density cable end connector of claim **7**, wherein the shielding plate is embedded in the first insulator.

9. The high-density cable end connector of claim **7**, wherein the shielding plate is embedded in the second insulator.

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